

**The Detection of DWI at BACs Below 0.10**

*Final Report*

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## **Executive Summary**

This report documents the research activities and presents the results of a study conducted for the National Highway Traffic Safety Administration (NHTSA) to identify driving and other behavioral cues that are associated with blood alcohol concentrations (BACs) below the 0.10 level. The ultimate objective of the research has been to develop training materials to assist law enforcement officers in the accurate detection of motorists who are driving while impaired (DWI).

### **Description of the Research**

The research and development project was composed of 13 major project tasks, conducted in two phases. During Phase I, a work plan was developed to guide all subsequent tasks, a comprehensive review of the low BAC literature was performed, interviews were conducted with DWI experts from across the United States, a data base of low BAC arrest reports was assembled, and two field studies were conducted. The analysis of archival, interview, arrest report, and field data collected by observers led to the identification of 34 driving cues and 10 post-stop cues for further evaluation.

Five law enforcement agencies participated in the second of the field studies, known as the preliminary field study, by recording the driving and post-stop cues observed for all enforcement stops, regardless of the disposition of the stop; the BACs of all drivers who exhibited objective signs of having consumed alcohol also were recorded. By collecting data about all enforcement stops that were made, it was possible to calculate the proportions of the stops in which specific cues were found in association with various BAC levels. All archival, interview, and field study data were analyzed, and recommendations for draft training materials were developed, as the final Phase I task.

A draft DWI detection guide, training booklet, and training video were developed based on the results of the preliminary field study; the materials included 24 driving and 10 post-stop cues. Law enforcement agencies representing 11 of the 15 states with 0.08 BAC limits for DWI were recruited to participate in the Phase II validation study. Participating officers reviewed the video and printed training materials, then completed a data collection form following every enforcement stop made, regardless of the disposition of the stop; the same form was used as in the preliminary field study, conducted previously. The validation study data were analyzed and a final version of the training materials, and this technical report, were prepared as the final Phase II project tasks.

Data were collected during more than 12,000 enforcement stops during this research project. The stops were made by several hundred participating officers, representing more than 50 law enforcement agencies from across the United States.

## Results

The results of the preliminary field study largely supported the 20 cues at the 0.08 BAC level that were presented on the original NHTSA DWI detection guide, which was developed in 1980 for the 0.10 BAC level. However, no cues were found that reliably predicted BACs below 0.08; that is, the cues that are key predictors of DWI at the 0.08 BAC level failed to emerge with useful probabilities at BAC levels below 0.08. The results of the Phase II validation study further confirmed the key cues that were contained in the original NHTSA guide, a few additional driving cues, and the 10 post-stop cues. The DWI driving cues were presented in functional categories in both the printed materials and the training video: Problems Maintaining Proper Lane Position, Speed and Braking Problems, Vigilance Problems, and Judgment Problems.

Slight modifications were made to the training materials, based on the results of the Phase II validation study. The final version of the DWI detection guide is reproduced below.

### DWI DETECTION GUIDE

*Weaving plus any other cue:  $p = \text{at least } .65$*

*Any two cues:  $p = \text{at least } .50$*

#### PROBLEMS MAINTAINING PROPER LANE POSITION

- Weaving
- Weaving across lane lines  $p=.50-.75$
- Straddling a lane line
- Swerving
- Turning with a wide radius
- Drifting
- Almost striking a vehicle or other object

#### SPEED AND BRAKING PROBLEMS $p=.45-.70$

- Stopping problems (too far, too short, or too jerky)
- Accelerating or decelerating for no apparent reason
- Varying speed
- Slow speed (10+ mph under limit)

#### VIGILANCE PROBLEMS $p=.55-.65$

- Driving in opposing lanes or wrong way on one-way
- Slow response to traffic signals
- Slow or failure to respond to officer's signals
- Stopping in lane for no apparent reason
- Driving without headlights at night\*
- Failure to signal or signal inconsistent with action\*

#### JUDGMENT PROBLEMS $p=.35-.90$

- Following too closely
- Improper or unsafe lane change
- Illegal or improper turn (too fast, jerky, sharp, etc.)
- Driving on other than the designated roadway
- Stopping inappropriately in response to officer
- Inappropriate or unusual behavior (throwing, arguing, etc.)
- Appearing to be impaired

#### POST STOP CUES $p\geq .85$

- Difficulty with motor vehicle controls
- Difficulty exiting the vehicle
- Fumbling with driver's license or registration
- Repeating questions or comments
- Swaying, unsteady, or balance problems
- Leaning on the vehicle or other object
- Slurred speech
- Slow to respond to officer/officer must repeat
- Provides incorrect information, changes answers
- Odor of alcoholic beverage from the driver

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\* $p\geq .50$  when combined with any other cue:

- Driving without headlights at night
- Failure to signal or signal inconsistent with action

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The probability of detecting DWI by random traffic enforcement stops at night has been found to be about three percent (.03).

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## **DWI Cues At BACs Below 0.10**

### ***A Review of the Literature***

The purpose of this review is to prepare information for the research team concerning the determination and validation of visual cues for the detection of motorists who are driving while impaired (DWI) with blood alcohol concentrations (BACs) below 0.10.

### **BACKGROUND**

An emphasis on DWI enforcement during the past decade has been a factor in the significant improvement in traffic safety, as represented by declining fatal and alcohol-involved crash rates. Despite the significant improvements in traffic safety during the past 30 years, particularly during the past decade, more than 40,000 people still perish each year as a result of motor vehicle crashes. The current US traffic fatality rate amount to a daily average of about 126 people – the equivalent of a Boeing 727 crashing every day of the year.

The economic losses from alcohol involved crashes are staggering at an estimated \$21 to \$24 billion annually (for property damage alone) (Miller, 1992). In 1990, the combined cost of all traffic collisions was \$137.5 billion, including 28 million vehicles damaged, 5.4 million people injured, and 44,531 lives lost (Blincoe & Faigin, 1992).

A reduction in the number of alcohol-involved crashes and the number of alcohol-impaired drivers on the road is a top priority. Numerous studies indicate that when DWI enforcement levels are increased, the number of alcohol involved collisions decrease (Hause, Chavez, Hannon, Matheson, 1977; Voas & Haus, 1987; Blomberg, 1992). However, many officers are unable to identify legally impaired drivers from their driving behavior, or even during the brief interview customary at a sobriety checkpoint. For example, in the Netherlands, as many as 32 percent of drivers with BACs above .05 might escape detection at checkpoint, when officers have the advantage of a face-to-face exchange (Gundy & Verschuur, 1986).

There are at least two clear solutions to the low BAC DWI detection problem: 1) Random Breath Testing (RBT) to objectively detect drivers operating above the legal limit; and, 2) increased officer sensitivity to behavioral cues exhibited at lower BAC levels. Although the RBT method is operating effectively in Australia (McCaul & McLean, 1990), it is probably not an appropriate program for the United States. Fourth Amendment rights currently prevent random breath testing; for example, testing only can occur at a sobriety checkpoint after probable cause has been established (Voas, 1991). Thus, the most likely solution to improving detection of low BACs is to improve the DWI detection ability of law enforcement officers.

In 1980, Harris et al. conducted NHTSA sponsored research to determine the behavioral cues for on-the-road detection of DWI. The final product of this Anacapa Sciences' study was a DWI Detection Guide providing 20 visual cues commonly exhibited by impaired drivers with a BAC equal to or greater than 0.10. The Guide provides the probability for each cue of discriminating between Driving While Impaired (DWI) and Driving While Sober (DWS). The DWI Detection Guide and supporting training materials are part of the DWI Detection and Standardized Field Sobriety Testing course currently distributed by NHTSA (NHTSA, 1990). Surprisingly, although there has been a limited evaluation of the DWI Detection Guide (Vingilis et al., 1983), the only additional research of this type that has been performed since 1980 was a NHTSA sponsored study to develop a motorcycle DWI detection guide (Stuster, 1993).

It is legitimate to question whether a cue guide calibrated for the 0.08 level would appear very similar if not identical to the DWI detection guide developed nearly 20 years ago by Anacapa Sciences. A new, lower BAC limit DWI detection guide might ultimately appear similar to the old guide, but the research is important for at least three reasons.

1. The research that supported the development of the DWI Detection Guide was conducted 18 years ago. Many things have changed considerably since the late 1970s. It is not unreasonable to suspect that some fundamental changes might be reflected in the behavioral cues associated with driver impairment. And, there *might* be behaviors that correlate more closely with lower than higher BACs.
2. At the very least, a periodic reprise of a research and development effort is warranted if the work involved important public policy and enforcement implications. The DWI Detection Guide and training program have not been reviewed or revised since they were developed. Increased awareness of DWI issues and public support for DWI enforcement in recent years contribute to the need to upgrade and make current an important decision aid and training program that is used by law enforcement personnel from across the U.S.
3. It is essential for researchers to view the issue of DWI detection from the perspective of an officer on patrol. A patrol officer wants to know the likelihood that a specific driver behavior is indicative of DWI at the (new) 0.08 level *or above*, or at the 0.04 level *or above*. The "or above" is important because as the BAC level is reduced the probability that a given cue is predictive of DWI rises – because all of the *or aboves* are included in the calculation. From the officer's perspective (in an 0.08 jurisdiction) it is usually irrelevant if the motorist is 0.08, 0.10, or some higher value – it is only important to determine that the motorist is 0.08 *or above*.

Although the modal BAC limit for DWI continues to be 0.10 in the United States, there is a definite trend towards lowering the limit. When the current project started in 1993, only five states had adopted a 0.08 percent legal limit, but by the conclusion of the research the number of states with a 0.08 limit had increased to 15. Further, the Commercial Motor Vehicle Safety Act of 1986 established a nationwide maximum BAC of 0.04 percent for all commercial drivers. In addition, several states have adopted a zero tolerance statute or a 0.02 percent BAC limit for youthful drivers. Studies that suggest low officer DWI detection rates, and improved low BAC detection when using passive alcohol sensors (Kiger et al., 1983; Jones et al., 1985; Vingilis and Gingilis, 1985), suggest the need for a DWI detection guide for levels below 0.10 percent BAC.

## RELEVANT RESEARCH

The trend of lowering BAC limits is a reflection of the growing body of evidence that alcohol begins to impair nervous function at BAC levels below 0.10 percent. Moskowitz and Robinson (1988) conducted a comprehensive literature review concerning the effects of alcohol on driving behavior, emphasizing the BACs at which impairment begins. A majority of studies found impairment at low BACs (below 0.07). Many studies found impairment at the 0.04 level and below.

Moskowitz and Robinson computed BACs for all studies, even those that included BAC data in the original report. Often these calculations resulted in higher BACs than were reported in the original study, probably because the older devices were inaccurate. The calculations also allowed for gender differences (by taking into account the different percentages of body water in females and males). If anything, the calculations performed by Moskowitz and Robinson lead to an over-estimation of BAC level. If this is the case, the impairments they report at various BAC levels actually might occur at lower BACs than reported later in this review.

In the Moskowitz study, factors were grouped into behavioral categories pertinent to driving. The following categories were affected at 0.05 percent BAC.

- Reaction time
- Divided attention
- Visual functions
- Tracking
- Information processing
- Perception

Driving behaviors that showed impairment at 0.08 percent to as low as 0.03 percent included:

- Steering
- Braking
- Speed control
- Lane tracking
- Gear changing
- Speed judgment
- Distance judgment

In addition, tasks requiring divided attention showed impairment at BACs as low as 0.02 percent. These driver behaviors are listed in the table presented at the end of this section; the table provides a comprehensive inventory of all DWI cues identified during the current review.

Although the Moskowitz and Robinson review is the most extensive source of information available about driver impairment at various BAC levels, several other studies identify potential cues for DWI detection. In an Anacapa Sciences' study conducted for the Insurance Institute for Highway Safety, Casey and Stuster (1982) identified the following 12 risky driving behaviors of both automobile and motorcycle operators.

- Running stop sign or traffic light
- Unsafe passing due to oncoming traffic
- Unsafe turn in front of oncoming or opposing traffic
- Following too closely
- Unsafe lane change or unsafe merging
- Weaving through traffic
- Crossing a double line in order to pass
- Passing on the right
- Excessive speed for conditions
- Improper turn
- Splitting traffic
- Stunts

Similarly, Treat et al. (1980), in a study of risky driving actions and their involvement in traffic collisions, identified the following 13 Unsafe Driving Actions.

- Pulling out in front of traffic
- Following behavior
- Speeding: Absolute/Over limit
- Speeding: Relative/For traffic conditions
- Turning in front of oncoming traffic
- Running stop sign or light
- Changing lanes or merging in front of traffic
- Driving left of center or on centerline
- Passing unsafely
- Driving off road to right
- Backing unsafely
- Turning too wide or too sharp
- Turning from wrong lane

Several of these unsafe driving actions also have been identified as indicators of driving while impaired in the Harris et al (1980) study: *following too closely*, *fast speed* (deleted from the final version of the DWI Detection Guide), *failing to respond to traffic signals or signs*, and *driving into opposing or crossing traffic*.

Additionally, several studies suggest stopping method as a primary difference between DWI and unimpaired driving (Attwood et al., 1980; Bragg et al., 1981; Compton, 1985). Differences included *braking sooner* and *stopping jerkily* when under the influence of alcohol.

In a study developing and validating the sobriety field test battery, Tharp, Burns, and Moskowitz (1981) reported the reasons for stopping suspected alcohol impaired drivers. The most common reasons were traffic infractions (e.g., speeding, failing to stop) rather than non-infraction driving behaviors such as weaving or drifting. There is significant overlap between the behaviors reported by Tharp et al. (1981) and the DWI on-the-road detection cues identified by Harris et al. (1980).

In a study evaluating screening procedures for police officers at sobriety checkpoints, cues noticed by officers were correlated with the BAC levels of the drivers. Compton (1985) found significant differences in stopping behavior. In general, drivers stopped smoothly at low BAC levels (0-0.04) and “jerkily” at higher BAC levels (0.10-0.15). Drivers with a low BAC did not serve, those with higher BACs (greater than 0.10) did. Cues identified by Compton that related to driving and stopping behaviors, and personal appearance, are presented in the comprehensive table at the end of this review. The cues identified in the Compton study include personal appearance variables not previously identified in the 1980 Harris et al. study. These cues include:

- Odor of alcohol
- Face flushed
- Speech slurred
- Eyes dilated
- Demeanor
- Hair disheveled
- Poor dexterity
- Clothes disheveled

Of these personal appearance variables, *odor of alcohol*, *face flushed*, and *eyes dilated* appear to be the most promising for DWI detection at low BAC levels.



## **CONCLUSIONS**

The objective of the current study is to develop an appropriate set of behaviors that can be used by field officers to accurately identify motorists who are driving while impaired at the 0.08 level, and to determine if cues are available that predict 0.04 and 0.02 BAC levels. No sources were identified that specifically identify behavioral cues for alcohol impairment at the lower levels. However, a table of potentially applicable behaviors has been prepared, based on a comprehensive review of the literature. This list, presented in the following table, includes all behaviors previously discussed in this review, and shows the considerable agreement among the studies. The behaviors identified here later will be combined with cues identified during interviews with DWI patrol experts, and from the archival research. The resulting comprehensive inventory of DWI cues then will be used to develop data collection forms for the first of the field studies.